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NEW PERMIAN REPTILES: RHACHITOMOUS
VERTEBRAE

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On the last day of field work by the University of Chicago Expedition to the Permian of Texas in the autumn of 1909, Mr. Lawrence Baker of the expedition discovered on Craddock's Ranch, about six miles from the town of Seymour, a remarkable deposit of fossil bones. All that could be done at the time was to collect a quantity of the loose bones from the surface. Work was begun upon the deposit by Mr. Paul Miller the present season, and, although the results obtained were not what had been hoped for and confidently expected, perhaps two hundred or more specimens were obtained. The bones were found almost invariably isolated, but in the most perfect preservation, for the most part entirely free from matrix; others were more or less covered by, or cemented together in, nodular concretions. The clay beds in which they were found, because of their usual barrenness, had never been thoroughly examined by previous collectors, and the bone deposit, though but a few hundred feet away from a well-traveled road, had been overlooked.

An incomplete examination of the material obtained shows a great variety of genera, not the less interesting because of their association. It includes various shark spines; a small quantity of *Diplocaulus* remains; at least three other forms of unidentified

amphibians represented by limb bones and parts of skulls; and certain large intercentra which agree well with those of *Trimero-rhachis*. At least one of these amphibians has a wide dermal armor of a new kind, probably belonging with one or the other of the humeri from this deposit figured by me in my recent paper on *Cacops*.¹ Other limb bones and such parts of the carapace as have been recovered I will figure as soon as opportunity permits.

Among the reptile remains there are representatives of at least seven genera, including three distinct species of *Dimetrodon*, one of them the largest vertebrate hitherto recorded from the Permian of Texas; numerous vertebrae and teeth of *Diadectes*; limb bones which agree well with Case's figures of *Clepsydrops natalis*, and with limb bones in the collection obtained elsewhere; femora and humeri, as well as other limb bones of at least two distinct genera which I cannot yet identify, some of which are, with scarcely a doubt, new; vertebrae, parts of a humerus and femur which I refer to *Desmospondylus*; and the genus *Araeoscelis* herein described. Rather interesting is the fact that, so far, no certain evidence is forthcoming of the Pariotichidae, the curious acrodont *Pantylus*, Poliosauridae, Eryopidae, or Cricotidae. A few vertebrae having short spines with a pair of lateral tubercles suggest the probability of *Naosaurus*, and it is possible that some of the girdles and limb bones may be of this genus. Altogether I recognize in the deposit evidences of fourteen or fifteen genera and seventeen species.

Among the material recovered from this deposit is a temnospondylous coracoscapula, in which the three elements are separate. The suture between the coracoid and scapula is quite as in the pelycosaurian girdle, passing directly forward through the pre-glenoid articular facet and above the supracoracoid foramen. The metacoracoid is small, a mere vestige in fact. The evidence furnished, not only by the temnospondyls but by the almost identical structure of the coracoscapula of the contemporary reptiles, is, it seems to me, conclusive that there is no such bone as the pro-coracoid, that the coracoid of all modern reptiles is homologous with the anterior element, the so-called procoracoid, and not with the posterior one, which has disappeared, or remains as the merest

¹ *Bull. Geol. Soc. Amer.*, XXI (1910), 249, Pl. XV, Figs. 4, 5.

fused vestige. For this reason I abandon the term procoracoid and adopt the terms metacoracoid and coracoid, or epicoracoid if one desires a distinctive name for the anterior element, after Howes and Lydekker, the former of whom reached the same conclusion from the study of the mammals.

Araeoscelidae, family new.

Araeoscelis gracilis, genus and species new.

This species is represented by numerous remains found associated in a space of a few square feet, including various limb bones and vertebrae found free in the clay, and three or four more or less complete skeletons imbedded in clay nodules—in a more or less disturbed condition. There are parts or wholes of four or five skulls among them, but unfortunately their delicacy is such that they are more or less distorted and only by a careful preparation with needle and lens can one hope to determine their characters. This much however may be said: The teeth are placed closely together and are of uniform size, obtusely pointed as seen from the side, with their bases rather wider than long; there is but a single row. There is a row of slender conical teeth on the palate. The orbits are large, and almost certainly there is a single large temporal vacuity. The skull is lizard-like in shape, in the smallest about 30 millimeters in length; in the largest about 50.

The vertebrae, of which there are numerous free examples in the collection, in addition to several more or less complete series, in the nodules, are remarkable for their slenderness and delicacy. The dorsal vertebrae (Figs. 13, 17) are elongate, narrowly keeled below, with a rudimentary spine in front; there is a short diapophysis just back of the front zygapophyses; and intercentra are present.

The ribs, of which there are numerous free representatives, are rather stout and single headed—a unique character if it is representative of the whole dorsal series. The caudal vertebrae (Plate I, Figs. 11, 12) are remarkable for their great elongation and slenderness, having a slender carina on the under side, and a small parapophysial facet on each side in front, for the attachment of ribs, another remarkable character. The pectoral and pelvic girdles are present in at least two specimens, but are scarcely visible in

the hard matrix, save that the clavicles and interclavicle are seen to be very slender.

It is in the limb bones that the chief distinctive characters of the genus are found, characters hitherto unknown among American Permian vertebrates, characters which indicate a quick-running terrestrial, or, more probably, climbing reptile. The humerus (Plate I, Figs. 4, 5) is very slender and delicate, with slightly expanded extremities and a somewhat curved shaft. The articular head is elongate oval in shape, imperfectly separated from the lateral process, which is situated much closer to the head than in any other Permian reptile known to me. The bicipital fossa is rather deep, and there is no distinct median process. The distal extremity is very thin and flat, and only moderately expanded on the ulnar side. The entepicondylar foramen is small, and is situated some distance above the lower end. On the radial side there is a small ectepicondylar foramen situated close to the distal margin, formed by a bridge over the end of the ectepicondylar groove; it is very like the foramen of *Iguana*. The capitellum for the radius is perfectly formed, as is also the trochlear surface for the ulna; both of them are very small for the slender epipodial bones. There is no more characteristic bone in the early reptiles than the humerus. "Ein geübtes Auge und ein durch Nachdenken geschaffter Blick findet in dem Humerus der Reptilien zahlreiche Momente, welche von mehr oder minder systematischer Bedeutung sind, welche aber, was noch wichtiger ist, zugleich ein Stück Genealogie ablesen lassen."¹ Among Permian reptiles I know of none other in which the length exceeds the greatest width more than two and a half times; in the present species the length is three and three-fourths times the greatest width, a difference not often exceeded among reptiles. And, even in those reptiles with a higher index, I know of none in which the shaft is proportionally more slender. This extreme slenderness, together with the smoothness of the bones, the absence of muscular rugosities, and the perfectly formed articular surfaces, points, I think, toward climbing habits, or at least toward purely terrestrial habits. For comparison I have given in the plate (Figs. 1, 2) the most slender humerus of the American

¹ Fürbringer, *Jenaischer Zeitschr. für Naturwissensch.*, XXXIV (1900), 555.

Permian that I knew hitherto, and I know no less than twenty different forms of Permian humeri. It is that of one of the smallest of known Permian reptiles, *Pleuristion* Case, belonging in the Pariotichidae. As will be seen, however, the expansion of the extremities is great, though the shaft is slender. In the same plate (Fig. 3) I give a figure of the humerus of *Sphenodon punctatus* for comparison. It will be observed how clumsy the bone is in comparison with that of *Araeoscelis*. For comparison's sake I figure the humeri of *Pleuristion* and *Sphenodon* twice natural size. The concurrence of an entepicondylar foramen and an ectepicondylar groove is found in the pelycosaurs, but the groove is never converted into a foramen. That the presence of a foramen in the present genus is of great phylogenetic significance I do not believe.

The same slenderness is characteristic of the femur and leg bones. In Plate I, Figs. 7 and 8, I give, enlarged one-half for the sake of comparison, illustrations of a femur of one of the numerous young specimens, specimens lacking the articular ossifications and muscular markings. That it belongs with the same species as does the larger bone shown natural size in Figs. 9 and 10 there can be no doubt, notwithstanding the apparent differences, since about a dozen femora of various sizes are present in the collection, as also many humeri of various degrees of ossification and size. In the side view will be seen the remarkable sigmoid curvature so characteristic of the bone. The adult bone shows sharply defined the articular surfaces for epipodial bones, and, proximally, the well-developed, rounded head and trochanter. The shaft is proportionally somewhat stouter than is that of the juvenile bone, and the extremities are more sharply expanded. The tibia and fibula are extremely slender, very nearly or quite the full length of the femora; the tibia has a well-developed and protuberant cnemial process, better developed than I have observed in any other Permian vertebrate. The metapodials are likewise very slender, those of the hind feet apparently more so than those of the front feet, as are also their phalanges. I hope to be able in a later communication to give the complete or nearly complete structure of the hind extremities at least. The claws are slender and

sharp, the phalanges well formed. All the bones of the skeleton are very hollow.

Upon the whole the present animal must be a remarkably long-legged and long-tailed reptile, probably eighteen inches or more in length.

There are several small reptiles from the American Permian of which we yet have no published knowledge of the extremities, such as *Isodectes*, *Helodectes*, and *Pariotichus* sens. str., the most of which are at once eliminated from comparison with the present genus by reason of their roofed-over skulls. *Tomicosaurus* Case, described from a fragment of a mandible and several arches of vertebra differs in being a larger animal, and in the character of the teeth, as described by Case. The front teeth neither in the upper nor lower jaws are elongated or incisiform. Nothing is shown in the figures of the diapophyses. The two small vertebrae upon which the genus and species *Embolophorus fritillus* Cope were founded differ materially from those of the present genus. As to its ordinal position, nothing definite can be said of *Araeoscelis* till the skulls have been cleaned and studied, and possibly not even then, save of the presence of a temporal vacuity. To locate such a genus in the same group with *Dimetrodon* or *Naosaurus* seems a bit absurd.

Casea broilii, genus and species new.

The material upon which the present genus and species are based comprises, probably, several complete skeletons found associated with skeletons of *Varanosaurus* and *Cacops*.¹ The complete working out of the material may require a year or more. The characters are, hence, drawn from those parts of one skeleton now prepared, comprising the larger part of a tail, the sacrum, two lumbar vertebrae, pelvis, and the complete hind legs. I take pleasure in naming the genus and species after Doctors Case and Broili, who have extended our knowledge of the American Permian fauna so materially.

The chief character wherein the present genus differs from all hitherto known Permian reptiles of America is found in the ilium,

¹ *Bull. Geol. Soc. Amer.*, XXI (1910), 249-85, Pls. VI-XVI.

which has a broad anterior projection, and only a slight posterior one (Fig. 1, A) suggesting affinities with the African Therapsida.

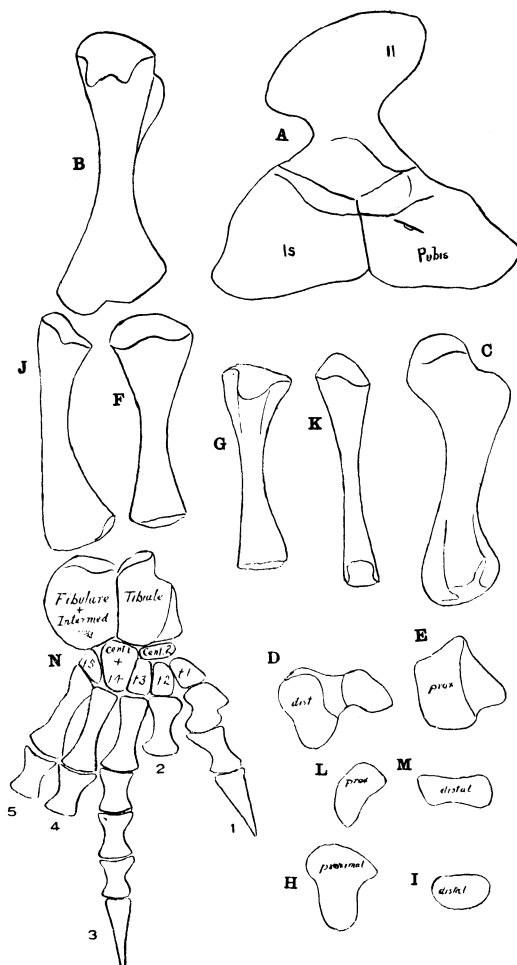


FIG. 1.—*Casea broilii* Will. A, right innominate, from without; B, right femur, dorsal; C, right femur, inner side; D, the same, distal end; E, the same, proximal end; F, right tibia, ventral; G, the same, dorsal; H, the same, proximal; I, the same, distal; J, right fibula, dorsal; K, the same, inner; L, the same, proximal; M, the same, distal; N, right foot, dorsal. All figures one-half natural size.

The pubes and ischia also differ markedly from both the clepsydroid and poliosaurid types in the absence of the platelike

projection anteriorly, agreeing rather better with the parietichid type. The symphysis is continuous or nearly so throughout, without a median puboischiadic interval. The sacrum has three pairs of large sacral ribs, agreeing in this respect with the Clepsydripidae, and very different from the Poliosauridae, which have but two pairs. The spines of the vertebrae of the basal caudal, sacral, and lumbar regions at least are low cylindrical, with a nodular extremity, quite unlike the elongated forms of the Clepsydripidae and the moderately elongated and flattened spines of the Poliosauridae. Evidently the short co-ossified ribs of the lumbar regions are united to both arch and sacrum, and the ribs more anteriorly have double heads. None of the spines are elongated, as is indicated by numerous isolated vertebrae found in the wash. The femur (Fig. 1, B, C, D, E), tibia (Fig. 1, F, G, H, I), and fibula (Fig. 1, J, K, L, M) are sufficiently well shown in the figures. They are all much heavier and shorter than the corresponding bones of *Varanosaurus*. Of the feet (Fig. 1, N) I figure only those bones which were found in natural articulation; the remainder were detached in the feet studied. The phalangeal formula, as in *Varanosaurus* and *Dimetrodon*, is 2, 3, 4, 5, 4. The foot differs materially from that of *Varanosaurus* and its allies in the large size of the fifth digit. The second centrale is well ossified, whereas in *Varanosaurus* it was small in both front and hind feet and remained cartilaginous throughout life. It is very evident also that the foot was placed at a greater angle with the leg in walking. That the animal was of the crawling, lizard-like habit and form is undoubted. The present genus in all probability belongs to the order Pelycosauria as at present bounded. Nevertheless the marked differences in the pelvis may indicate corresponding differences in the skull. Furthermore I protest against the union of the Poliosauridae, or *Varanosaurus* at least, in the same group with *Dimetrodon* or *Naosaurus*. The structure of the skull, with no lower temporal arcade, aside from other characters of the skeleton sufficiently justifies a subordinal position.

Trispodylus texensis, genus and species new.

A new genus and species of reptile is represented in the Chicago collection by a considerable part of a skeleton collected by Mr.

Paul Miller on Craddock's Ranch intimately associated with the remains of *Trematops* described by myself. The parts recovered consist of a nearly complete humerus, radius, ulna, numerous carpal and digital bones, a pelvis lacking part of the ischia and pubis, and a more or less connected series of nineteen vertebrae. The

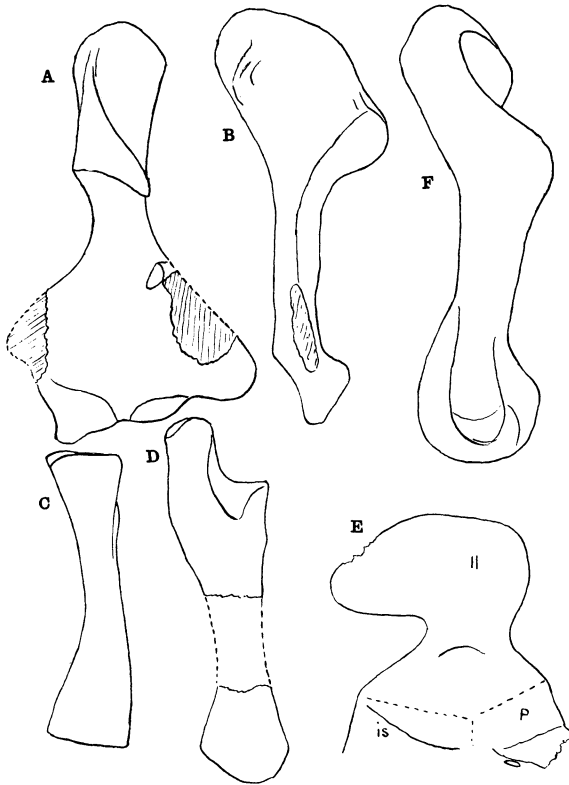


FIG. 2.—*Trispondylus texensis* Will. A, right humerus, ventral; B, the same, outer; C, right radius, dorsal; D, right ulna, dorsal; E, right ilium, outer; F, left femur, inner side. All figures one-half natural size.

vertebrae are in five series, three dorsal of three each, eight in another comprising two lumbar, three sacral, and three caudal, and two additional connected caudals. None of the spines of the vertebrae are preserved complete, but they are all evidently short. The centra are of nearly uniform length, a little shortened in the lumbar region, obtusely keeled below, or rather with the sides "pinched in." The ribs are double headed, the diapophyses anteri-

only unusually long. Three of the basal caudals have intercentra, the first chevron appearing between the third and fourth caudals. The three pairs of sacral ribs are turned broadly down at their extremities, the expansion of the first pair nearly equal to the combined extent of the second and third pairs. The ilium (Fig. 2, E) has the ordinary form, turned broadly backward, and is wholly without an anterior projection. The humerus (Fig. 2, A, B) is massive and broad, with the distal extremity greatly expanded; the radius and ulna (Fig. 2, C, D) are likewise stout bones. The front feet show the usual structure, so far as the preserved remains enable one to decide; the intermedium is large, the second centrale is ossified, and the pisiform articulates with the distal end of the ulna. The femur (Fig. 2, F) is likewise a stout bone, especially characterized by the low position of the trochanter.

The genus is removed from the Poliosauridae by the possession of three sacral vertebrae; from the Clepsydropsidae by the possession of short dorsal spines, and the different structure of the propodials, as will be seen by comparison of the same parts of *Clepsydrops* and *Dimetrodon*.

THE DEVELOPMENT OF HOLOSPONDYLOUS VERTEBRAE

In a recent paper¹ I discussed the views at present held as to the morphological significance of the rhachitinous pleurocentra and hypocentra in the evolution of vertebrae of the higher forms. The majority of paleontologists believe that the rhachitinous type of vertebra is a primitive one, though there are some, of whom Jaekel is one,² who deny it. The extraordinary resemblances in nearly all parts of the skeleton between the more specialized temnospondyls and the more generalized reptiles are almost a demonstration of genetic affinity. That we have in any known Permian forms the actual connecting links between the Amphibia and Reptilia is more than doubtful; it is more than probable that annectant forms must be sought for in older rocks, probably those of the lower part of the Pennsylvanian or Upper Carboniferous.

¹ *Bull. Geol. Soc. Amer.*, XXI (1910), 265.

² *Deutsch. geolog. Gesellsch.*, LVI (1904), 118; *Zoologisch. Anzeiger*, XXXIV (1909), 200.

If then we assume that the holospondylous vertebra has been evolved from the rhachitomous, it is a matter of much interest to determine how the evolution has occurred. The view which has obtained general acceptance, among American paleontologists at least, is that of Cope, so vigorously defended by Baur,¹ namely, that the pleurocentra have progressively developed to form the centrum of the amniote vertebra, the hypocentrum degenerating into the vestige usually called the intercentrum; while, as proposed by Cope and tentatively accepted by Baur, in the modern amphibians it has been the hypocentrum which has developed into the centrum, the pleurocentra disappearing. The theory more generally accepted by European writers is that the pleurocentra and hypocentrum have fused to form the centrum of all the higher vertebrates, the small elements called the intercentra representing, according to Gadow and others, the hypocentra pleuralia, which have been rarely found in the tail of certain temnospondyls. Or, in the words of Broili:

Bei den Rhachitomen das Hypozentrum den ventralen Halbring und das Paar der Pleurozentren den dorsalen Halbring des Wirbelkörpers repräsentirt; anderseits folgt daraus, dass weder das Hypozentrum noch die Pleurozentren allein dem eigentlichen Wirbelkörper der Amnioten homolog sind, sondern das beide zusammen Hypozentrum plus Pleurozentren desselben entsprechen.²

A study of the material in the University of Chicago collections has convinced me of the general correctness of Cope's contentions and the incorrectness of the opposing views.

It is well known that in the older reptiles the odontoid of the atlas is a larger bone than in modern reptiles or higher vertebrates, and also that there is in the oldest forms invariably a large intercalating intercentrum between the odontoid and the body of the axis below, a bone that is small or wanting in modern reptiles, as also the older Crocodilia. In *Dimetrodon*, as will be seen in the accompanying figure (Fig. 3), the odontoid functions as the real centrum of the atlas, reaching quite to the ventral side between the atlantal and axial hypocentra. It has a deep conical cavity

¹ "Everybody is convinced that the pleurocentra of the Rhachitomi represent the centra of the higher vertebrates; and that the intercentra are homologous to the intercentra of the Sphenodontidae," etc.—*Amer. Nat.* (1897), 975.

² *Monatschr. d. deutschen geologischen Gesellschaft*, LX (1908), 240.

in its posterior end, that in apposition with the body of the axis, a cavity which extends through the bone as the notochordal canal. Not only does this cavity extend through this bone but its orifice, in *Varanosaurus* at least, is in apposition with a similar cavity in the occipital condyle, conclusively proving the nature of the basioccipital. Between the odontoid and the axis, below, there is a large, massive intercentrum, even larger than the atlantal hypocentrum. This latter intercentrum gives support only in part to the neuropophyses of the atlas, which rest chiefly on the odontoid.

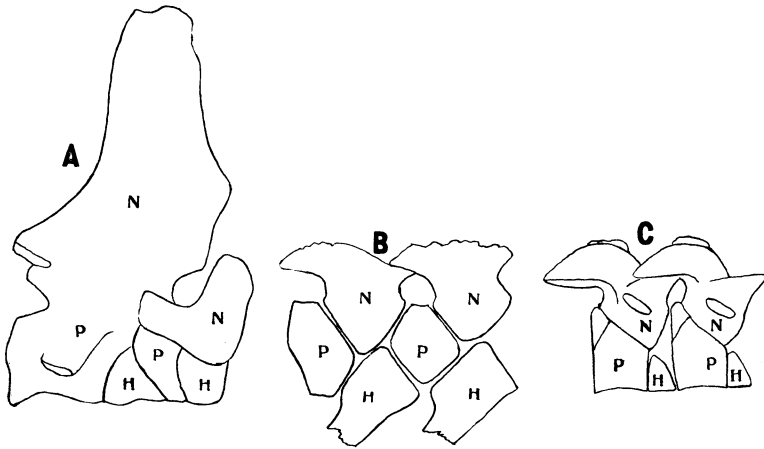


FIG. 3.—A, Atlas and axis of *Dimetrodon incisivus* Cope; B, caudal vertebrae of undetermined amphibian; C, vertebrae of *Desmospondylus anomalus* Will.; N, neurocentra; H, hypocentra; P, pleurocentra.

There can be no question that the odontoid is the combined pleurocentra of the atlantal vertebra, which has so far retained its primitive character that it gives chief support to the atlantal neuropophyses. Yet more conspicuously holospondylous in character is the atlas of *Poecilospondylus* Case, in which the dorsal arch appears to rest wholly upon the odontoid, and articulates in the usual way with the axis.¹ In *Eryops*, *Cacops*, and doubtless all other rhachitomous genera the vertebrae of the trunk have a perforating canal for the notochord formed by the junction of the pleurocentra in the middle above the hypocentrum, the three bones forming the canal; and it is chiefly because of this fact that Broili

¹ *Bulletin Amer. Mus. Nat. Hist.* (1910).

believes that the holospondylous centrum is formed by the fusion of the three bones. Under this theory, the intercentra, using the term as originally applied by Cope, must be morphologically different elements from the hypocentra. If such be really the case, it seems probable that all the known temnospondyl amphibians must be excluded from ancestral relationships with the reptiles, since none of them is known to possess additional elements in the trunk region. Aside from the improbability that the hypocentra pleuralia, known only in the tail of one or two temnospondyls I believe, have developed into so large a bone as is the axial intercentrum of *Dimetrodon*, the relations and structure of the axial and atlantal bones in the old reptiles furnish certain proof, it seems to me, that the odontoid is composed exclusively of the pleurocentra, though perforated by the notochordal canal; and Broili's argument falls to the ground.

Yet more conclusive evidence—it seems to me irrefutable—is furnished by two caudal vertebrae (Fig. 3, B) of an unidentified amphibian from the Texas Permian. The specimen was found by Mr. Paul Miller in the autumn of 1908 on the Little Wichita, unassociated with other bones. The size of the vertebrae rather precludes the probability of their belonging with *Eryops*, though possibly coming from near the extremity of the tail. However that may be, I doubt not that a similar structure will be found to be characteristic of *Eryops*, since by the aid of this specimen I determine a like structure in the tail of *Trematops*, as was indeed indicated by me in my paper descriptive of that genus.¹ Very probably the specimen pertains to a species of *Trimerorhachis*. The two vertebrae composing the specimen are closely associated, without distortion, and are uninjured, save for the loss of the greater part of the chevrons, and a part of the arch of the proximal vertebra. The two arches (NN), it will be seen in the figure, are wedged in between their adjacent pleurocentra (PP), resting in part upon the hypocentra (HH). The first pleurocentrum does not quite separate the two adjacent hypocentra below, which nearly touch at their extremities. The second pleurocentrum, however, is almost disklike, narrowed above and below, but separating by a

¹ *Journal of Geology*, XVII (1909), 647, Figs. 5, 16.

considerable interval both the arches and the hypocentra of the adjacent vertebrae. This pleurocentrum forms a complete ring, without traces of division, conically hollowed in its visible end and perforated by the notochordal canal. Its neurocentrum is much more closely and extensively combined with it than with the preceding pleurocentrum. In a few words, this vertebra is still typically rhachitinous, save that its fused pleurocentra form a disk separating the adjacent vertebrae, which is perforated like any holospondylous centrum by the notochord. The most imaginative eye will not see in this vertebra fused pleurocentra and hypocentrum with some other element taking the place of the hypocentrum, since the preceding apparently fused pleurocentra are not very different from the ordinary form. Doubtless the pleurocentra preceding these were progressively smaller, and those following progressively larger. To follow Jaekel's arguments to their extreme would necessitate the fusion of hypocentra and pleurocentra throughout, and the sudden introduction of an entirely different element in the chevrons to mimic the hypocentra, of all of which there is not the ghost of evidence!

The next stage in the evolution of the ordinary holospondylous vertebra may be seen in the reptile *Desmospondylus*, as recently described and figured by me,¹ an outline copy of two of the vertebrae of which I reproduce (Fig. 3, C). In his specimen it will be seen that the fused pleurocentra (PP) have increased in size, while the hypocentra (HH) have decreased, though still much larger relatively than in any other known reptile. The arch (N) rests in the same way upon the two adjacent pleurocentra, though functionally upon the posterior one, its own, and its lower extremity in front nearly touches the upper extremity of the hypocentrum.

From these three specimens it is not at all difficult, it seems to me, to understand clearly the way in which the different types of vertebrae have arisen. By the fusion of the neurocentrum with its respective hypocentrum, the embolomeric vertebra has arisen; by its sutural union with its respective pleurocentra the reptilian vertebra is produced; by the union of all three, I believe, the holospondylous amphibian vertebra has been evolved. It would

¹ *Bull. Geol. Soc. Amer.*, XXI (1910), 280.

require but little change in the size of the different parts to develop the second vertebra shown in B into one of those shown in C. In any event I think the specimens show conclusively that the hypocentra or intercentra are not the hypocentra pleuralia, as Gadow believes, nor the pleurocentra the fused pleurocentra and hypocentra, as Jaekel, Broili, and others believe.

Cope suggested that the pleurocentra were eliminated in the evolution of the holospondylous amphibian vertebra, but it seems more reasonable to me that there has been a fusion of all three elements in the Branchiosauria, Lepospondyli, and modern amphibians, from the fact that none of these amphibians are known to possess any vestiges as separate elements.

If this theory be true, that is the union of the hypocentra with some or all the other elements of the vertebrae in the amphibia, and their final loss, save as simple intercentra and chevrons in the amniota, it would offer of course the best class distinction between holospondylous amphibians and reptiles. In any event the structural differences seem too radical to unite forms with free chevrons articulating intercentrally with those having no free intercentra and the chevrons exogenous processes from the body of the vertebra. Nevertheless that is what is done in the order Microsauria. Baur some years ago reached the conclusion that *Hylonomus* and *Petrobates* were undoubted reptiles,¹ and his views were accepted by Fürbringer and others. A study of the specimen described by Cope and doubtfully referred by him to the species *Tuditonus punctulatus* Cope under the name *Isodectes* (*Eosauravus copei* Will., *Isodectes punctulatus* Moodie, nec Cope) convinces me that the genus is allied to *Hylonomus*, and consequently is a true microsauro, since *Hylonomus* Dawson is the type, with *Dendrerpeton* Owen, and *Hylerpeton* Owen, of the order Microsauria, as proposed by Dawson in 1863 (Airbreathers of the Coal Period). Whether *Hylonomus*, *Petrobates*, *Eosauravus*, and *Sauravus* Thevenin are true reptiles, even though having free chevrons, will not be positively determined until the structure of the skull has been made out. Whatever is the final disposition of them, they must be excluded from the Amphibia, and doubtless the ordinal name Microsauria will remain

¹ *Anatomischer Anzeiger*, XIV.

valid for them. With the elimination of these genera, and perhaps others, from the Amphibia there remain a number of others hitherto classed under the Microsauria, of which *Urocordylus*, *Crossotelos*, and perhaps *Diplocaulus* are typical, that are genuine stegocephalian amphibians, which can no more be classed with the Reptilia than a salamander can. They have exogenous chevrons, and double-headed ribs attached to body and arch, true amphibian characters, the former utterly unknown among reptiles, save apparently in such rare cases as *Clidastes* among the mosasaurs, purely the result of a secondary anchylosis. There have been plenty of terms proposed to include them, such as Nectridea Miall, Lepospondyli Zittel, Diplocaulia Moodie, Holospondyli Jaekel. For myself I prefer the term Lepospondyli. Jaekel's class Microsauria is untenable.

Whatever may be the final disposition of *Lysorophus*, which I have referred to the order Urodela or Caudata, there can be hardly a question of its urodelan affinities. It has nothing to do with the Gymnophiona. The abundant material in the University collections demonstrates the presence of small limbs in numerous specimens. Amphiuma-like in form it had Amphiuma-like habits and limbs. I may also add that the supposed proatlas described both by myself and Case is merely the arch of the so-called atlas.

EXPLANATION OF PLATE

FIG. 1, *Pleuristion brachycoelus* Case, left humerus, ventral side; FIG. 2, the same, outer side; FIG. 3, *Sphenodon punctatus*, left humerus, ventral side; FIG. 4, *Araeoscelis gracilis* Will., right humerus, inner side; FIG. 5, the same, ventral side; FIG. 6, the same, distal end, dorsal side; FIG. 7, *A. gracilis*, left femur of young individual, dorsal side; FIG. 8, the same, inner side; FIG. 9, *A. gracilis*, adult femur, dorsal side; FIG. 10, the same, ventral side; FIG. 11, *A. gracilis*, caudal vertebra, side view; FIG. 12, the same, from below; FIG. 13, *A. gracilis*, dorsal vertebra, from side; FIG. 14, *A. gracilis*, upper part of tibia; FIG. 15, *A. gracilis*, metapodial; FIG. 16, *A. gracilis*, phalanges in position as found; FIG. 17, *A. gracilis*, dorsal vertebra; FIG. 18, *A. gracilis*, sketch of skull; FIG. 19, *A. gracilis*, mandibular teeth. All figures natural size, save where indicated.

